



#6

Sequence List

<110> Betenbaugh et al.

<120> Engineering Intracellular Sialylation Pathways

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<141> 2001-08-16

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Thr Pro Met Thr Glu Asn Gly Glu Ile Asn Phe Ser Val Ile Gly Gln
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Tyr Val Asp Tyr Leu Val Lys Glu Gln Gly Val Lys Asn Ile Phe Val
35 40 45

aat ggc aca aca gga gaa ggc ctg tcc ctg agc gtc tca gag cgt cgc
Asn Gly Thr Thr Gly Glu Gly Leu Ser Leu Ser Val Ser Glu Arg Arg
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cag gtt gca gag gag tgg gtg aca aaa ggg aag gac aag ctg gat cag
Gln Val Ala Glu Glu Trp Val Thr Lys Gly Lys Asp Lys Leu Asp Gln
65 70 75 80

gtg ata att cac gta gga gca ctg agc ttg aag gag tca cag gaa ctg
Val Ile Ile His Val Gly Ala Leu Ser Leu Lys Glu Ser Gln Glu Leu
85 90 95

48

96

144

192

240

288

gcc caa cat gca gca gaa ata gga gct gat ggc atc gct gtc att gca Ala Gln His Ala Ala Glu Ile Gly Ala Asp Gly Ile Ala Val Ile Ala	336
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145 150 155 160	
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180 185 190	
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35 40 45
Asn Gly Thr Thr Gly Glu Gly Leu Ser Leu Ser Val Ser Glu Arg Arg
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Gln Val Ala Glu Glu Trp Val Thr Lys Gly Lys Asp Lys Leu Asp Gln
65 70 75 80
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Ala Gln His Ala Ala Glu Ile Gly Ala Asp Gly Ile Ala Val Ile Ala
100 105 110
Pro Phe Phe Leu Lys Pro Trp Thr Lys Asp Ile Leu Ile Asn Phe Leu
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Ile Pro Ala Leu Thr Gly Val Lys Ile Arg Ala Glu Glu Leu Leu Asp
145 150 155 160
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165 170 175
Thr Asp Leu Leu Asp Phe Gly Gln Cys Val Asp Gln Asn Arg Gln Gln
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Gln Phe Ala Phe Leu Phe Gly Val Asp Glu Gln Leu Leu Ser Ala Leu
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ggc ggc cag ggc cga ggt gtg gag aag ccc ccg cac ctg gca gcc cta	144
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35 40 45	

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Asp Ser Gly Ala Phe Gln Ser Val Trp Val Ser Thr Asp His Asp Glu	
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Ile Glu Asn Val Ala Lys Gln Phe Gly Ala Gln Val His Arg Arg Ser	
100 105 110	

tct gaa gtt tca aaa gac agc tct acc tca cta gat gcc atc ata gaa	384
Ser Glu Val Ser Lys Asp Ser Ser Thr Ser Leu Asp Ala Ile Ile Glu	
115 120 125	

ttt ctt aat tat yat aat gag gkt gac att gta gga aat att caa gct	432
Phe Leu Asn Tyr Xaa Asn Glu Xaa Asp Ile Val Gly Asn Ile Gln Ala	
130 135 140	

act tct yca tgt tta cat cct act gat ctt caa aaa gtt gca gaa atg	480
Thr Ser Xaa Cys Leu His Pro Thr Asp Leu Gln Lys Val Ala Glu Met	
145 150 155 160	

att cga gaa gaa gga tat gat tct gkt ttc tct gtt gtg aga cgc cat	528
Ile Arg Glu Glu Gly Tyr Asp Ser Xaa Phe Ser Val Val Arg Arg His	
165 170 175	

cag ttt cga tgg agt gaa att cag aaa gga gtt cgt gaa gtg acc gaa	576
Gln Phe Arg Trp Ser Glu Ile Gln Lys Gly Val Arg Glu Val Thr Glu	
180 185 190	

cct ctg aat tta aat cca gct aaa cgg cct cgt cga caa gac tgg gat	624
Pro Leu Asn Leu Asn Pro Ala Lys Arg Pro Arg Arg Gln Asp Trp Asp	
195 200 205	

gga gaa tta tat gaa aat ggc tca ttt tat ttt gct aaa aga cat ttg	672
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Ile	Glu	Met	Gly	Tyr	Leu	Gln	Gly	Gly	Lys	Trp	His	Thr	Thr	Lys	Cys	
225					230				235					240		
gag	ctg	gaa	cat	agt	gtg	gat	ata	gat	gtg	gat	att	gat	tgg	cct	att	768
Glu	Leu	Glu	His	Ser	Val	Asp	Ile	Asp	Val	Asp	Ile	Asp	Trp	Pro	Ile	
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Ala	Glu	Gln	Arg	Val	Leu	Arg	Tyr	Gly	Tyr	Phe	Gly	Lys	Glu	Lys	Leu	
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Lys	Glu	Ile	Lys	Leu	Leu	Val	Cys	Asn	Ile	Asp	Gly	Cys	Leu	Thr	Asn	
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Val	Arg	Leu	Ile	Ser	Glu	Arg	Ala	Cys	Ser	Lys	Gln	Thr	Leu	Ser	Ser	
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Leu	Lys	Leu	Asp	Cys	Lys	Met	Glu	Val	Ser	Val	Ser	Asp	Lys	Leu	Ala	
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gca	tat	ctt	gga	aat	gaa	gtg	tct	gat	gaa	gag	tgc	ttg	aag	aga	gtg	1152
Ala	Tyr	Leu	Gly	Asn	Glu	Val	Ser	Asp	Glu	Glu	Cys	Leu	Lys	Arg	Val	
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Phe	Ala	Glu	His	Ile	Cys	Leu	Leu	Met	Glu	Lys	Val	Asn	Asn	Ser	Cys	
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Gln	Lys															

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Ile	Leu	Ala	Arg	Gly	Gly	Ser	Lys	Gly	Ile	Pro	Leu	Lys	Asn	Ile	Lys
	50					55					60				
His	Leu	Ala	Gly	Val	Pro	Leu	Ile	Gly	Trp	Val	Leu	Arg	Ala	Ala	Leu
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Ser	Glu	Val	Ser	Lys	Asp	Ser	Ser	Thr	Ser	Leu	Asp	Ala	Ile	Ile	Glu
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Gln	Phe	Arg	Trp	Ser	Glu	Ile	Gln	Lys	Gly	Val	Arg	Glu	Val	Thr	Glu
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Pro	Leu	Asn	Leu	Asn	Pro	Ala	Lys	Arg	Pro	Arg	Arg	Gln	Asp	Trp	Asp
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Gly	Glu	Leu	Tyr	Glu	Asn	Gly	Ser	Phe	Tyr	Phe	Ala	Lys	Arg	His	Leu
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Ile	Glu	Met	Gly	Tyr	Leu	Gln	Gly	Lys	Trp	His	Thr	Thr	Lys	Cys	
					225			230			235			240	
Glu	Leu	Glu	His	Ser	Val	Asp	Ile	Asp	Val	Asp	Ile	Asp	Trp	Pro	Ile
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Ala	Glu	Gln	Arg	Val	Leu	Arg	Tyr	Gly	Tyr	Phe	Gly	Lys	Glu	Lys	Leu
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Val Lys Asp Ala Ile Gly Ile Ser Leu Leu Lys Lys Ser Gly Ile Glu		
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Val Arg Leu Ile Ser Glu Arg Ala Cys Ser Lys Gln Thr Leu Ser Ser		
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Leu Lys Leu Asp Cys Lys Met Glu Val Ser Val Ser Asp Lys Leu Ala		
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Val Val Asp Glu Trp Arg Lys Glu Met Gly Leu Cys Trp Lys Glu Val		
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Ala Tyr Leu Gly Asn Glu Val Ser Asp Glu Glu Cys Leu Lys Arg Val		
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Gly Leu Ser Gly Ala Pro Ala Asp Ala Cys Ser Tyr Ala Gln Lys Ala		
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His Pro Cys Phe Ile Ile Ala Glu Ile Gly Gln Asn His Gln Gly Asp		
20	25	30
ctg gac gta gcc aag cgc atg atc cgc atg gcc aag gag tgt ggg gct		144
Leu Asp Val Ala Lys Arg Met Ile Arg Met Ala Lys Glu Cys Gly Ala		
35	40	45
gat tgt gcc aag ttc cag aag agt gag cta gaa ttc aag ttt aat cgg		192
Asp Cys Ala Lys Phe Gln Lys Ser Glu Leu Glu Phe Lys Phe Asn Arg		
50	55	60
aaa gcc ttg gag agg cca tac acc tcg aag cat tcc tgg ggg aag acg		240
Lys Ala-Leu Glu Arg Pro Tyr Thr Ser Lys His Ser Trp Gly Lys Thr		
65	70	75
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tac ggg gag cac aaa cga cat ctg gag ttc agc cat gac cag tac agg		288
Tyr Gly Glu His Lys Arg His Leu Glu Phe Ser His Asp Gln Tyr Arg		
85	90	95
gag ctg cag agg tac gcc gag gag gtt ggg atc ttc ttc act gcc tct		336
Glu Leu Gln Arg Tyr Ala Glu Glu Val Gly Ile Phe Phe Thr Ala Ser		
100	105	110

ggc atg gat gag atg gca gtt gaa ttc ctg cat gaa ctg aat gtt cca Gly Met Asp Glu Met Ala Val Glu Phe Leu His Glu Leu Asn Val Pro 115 120 125	384
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aag aca gcc aaa aaa ggt cgc cca atg gtg atc tcc agt ggg atg cag Lys Thr Ala Lys Lys Gly Arg Pro Met Val Ile Ser Ser Gly Met Gln 145 150 155 160	480
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Lys Ala Leu Glu Arg Pro Tyr Thr Ser Lys His Ser Trp Gly Lys Thr
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Tyr Gly Glu His Lys Arg His Leu Glu Phe Ser His Asp Gln Tyr Arg
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Gly Met Asp Glu Met Ala Val Glu Phe Leu His Glu Leu Asn Val Pro
115 120 125
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130 135 140
Lys Thr Ala Lys Lys Gly Arg Pro Met Val Ile Ser Ser Gly Met Gln
145 150 155 160
Ser Met Asp Thr Met Lys Gln Val Tyr Gln Ile Val Lys Pro Leu Asn
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Pro Asn Phe Cys Phe Leu Gln Cys Thr Ser Ala Tyr Pro Leu Gln Pro
180 185 190
Glu Asp Val Asn Leu Arg Val Ile Ser Glu Tyr Gln Lys Leu Phe Pro
195 200 205
Asp Ile Pro Ile Gly Tyr Ser Gly His Glu Thr Gly Ile Ala Ile Ser
210 215 220
Val Ala Ala Val Ala Leu Gly Ala Lys Val Leu Glu Arg His Ile Thr
225 230 235 240
Leu Asp Lys Thr Trp Lys Gly Ser Asp His Ser Ala Ser Leu Glu Pro
245 250 255
Gly Glu Leu Ala Glu Leu Val Arg Ser Val Arg Leu Val Glu Arg Ala
260 265 270
Leu Gly Ser Pro Thr Lys Gln Leu Leu Pro Cys Glu Met Ala Cys Asn
275 280 285
Glu Lys Leu Gly Lys Ser Val Val Ala Lys Val Lys Ile Pro Glu Gly
290 295 300
Thr Ile Leu Thr Met Asp Met Leu Thr Val Lys Val Gly Glu Pro Lys
305 310 315 320
Ala Tyr Pro Pro Glu Asp Ile Phe Asn Leu Val Gly Lys Lys Val Leu
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Ser Val Asp Ile Ala Arg Glu Met Ile Leu Lys Ala Lys Glu Ala Gly
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gtt aat gca gta aaa ttc caa aca ttt aaa gct gat aaa tta att tca 144
Val Asn Ala Val Lys Phe Gln Thr Phe Lys Ala Asp Lys Leu Ile Ser
35 40 45

gct att gca cct aag gca gag tat caa ata aaa aac aca gga gaa tta 192
Ala Ile Ala Pro Lys Ala Glu Tyr Gln Ile Lys Asn Thr Gly Glu Leu
50 55 60

gaa tct cag tta gaa atg aca aaa aag ctt gaa atg aag tat gac gat 240
Glu Ser Gln Leu Glu Met Thr Lys Lys Leu Glu Met Lys Tyr Asp Asp
65 70 75 80

tat ctc cat cta atg gaa tat gca gtc agt tta aat tta gat gtt ttt 288
Tyr Leu His Leu Met Glu Tyr Ala Val Ser Leu Asn Leu Asp Val Phe
85 90 95

tct acc cct ttt gac gaa gac tct att gat ttt tta gca tct ttg aaa 336
Ser Thr Pro Phe Asp Glu Asp Ser Ile Asp Phe Leu Ala Ser Leu Lys
100 105 110

caa aaa ata tgg aaa atc cct tca ggt gag tta ttg aat tta ccg tat 384
Gln Lys Ile Trp Lys Ile Pro Ser Gly Glu Leu Leu Asn Leu Pro Tyr
115 120 125

ctt gaa aaa ata gcc aag ctt ccg atc cct gat aag aaa ata atc ata 432
Leu Glu Lys Ile Ala Lys Leu Pro Ile Pro Asp Lys Lys Ile Ile Ile
130 135 140

tca aca gga atg gct act att gat gag ata aaa cag tct gtt tct att 480
Ser Thr Gly Met Ala Thr Ile Asp Glu Ile Lys Gln Ser Val Ser Ile
145 150 155 160

ttt ata aat aat aaa gtt ccg gtt ggt aat att aca ata tta cat tgc 528
Phe Ile Asn Asn Lys Val Pro Val Gly Asn Ile Thr Ile Leu His Cys
165 170 175

aat act gaa tat cca acg ccc ttt gag gag gta aac ctt aat gct att 576
Asn Thr Glu Tyr Pro Thr Pro Phe Glu Asp Val Asn Leu Asn Ala Ile
180 185 190

aat gat ttg aaa aaa cac ttc cct aag aat aac ata ggc ttc tct gat 624
Asn Asp Leu Lys Lys His Phe Pro Lys Asn Asn Ile Gly Phe Ser Asp
195 200 205

cat tct agc ggg ttt tat gca gct att gcg gcg gtg cct tat gga ata	672
His Ser Ser Gly Phe Tyr Ala Ala Ala Ala Val Pro Tyr Gly Ile	
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	220
act ttt att gaa aaa cat ttc act tta gat aaa tct atg tct ggc cca	720
Thr Phe Ile Glu Lys His Phe Thr Leu Asp Lys Ser Met Ser Gly Pro	
225	230
	235
	240
gat cat ttg gcc tca ata gaa cct gat gaa ctg aaa cat ctt tgt att	768
Asp His Leu Ala Ser Ile Glu Pro Asp Glu Leu Lys His Leu Cys Ile	
245	250
	255
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Gly Val Arg Cys Val Glu Lys Ser Leu Gly Ser Asn Ser Lys Val Val	
260	265
	270
aca gct tca gaa agg aag aat aaa atc gta gca aga aag tct att ata	864
Thr Ala Ser Glu Arg Lys Asn Lys Ile Val Ala Arg Lys Ser Ile Ile	
275	280
	285
gct aaa aca gag ata aaa aaa ggt gag gtt ttt tca gaa aaa aat ata	912
Ala Lys Thr Glu Ile Lys Lys Gly Glu Val Phe Ser Glu Lys Asn Ile	
290	295
	300
aca aca aaa aga cct ggt aat ggt atc agt ccg atg gag tgg tat aat	960
Thr Thr Lys Arg Pro Gly Asn Gly Ile Ser Pro Met Glu Trp Tyr Asn	
305	310
	315
	320
tta ttg ggt aaa att gca gag caa gac ttt att cca gat gaa tta ata	1008
Leu Leu Gly Lys Ile Ala Glu Gln Asp Phe Ile Pro Asp Glu Leu Ile	
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Val Asn Ala Val Lys Phe Gln Thr Phe Lys Ala Asp Lys Leu Ile Ser	
35 40 45	
Ala Ile Ala Pro Lys Ala Glu Tyr Gln Ile Lys Asn Thr Gly Glu Leu	
50 55 60	
Glu Ser Gln Leu Glu Met Thr Lys Lys Leu Glu Met Lys Tyr Asp Asp	
65 70 75 80	
Tyr Leu His Leu Met Glu Tyr Ala Val Ser Leu Asn Leu Asp Val Phe	
85 90 95	
Ser Thr Pro Phe Asp Glu Asp Ser Ile Asp Phe Leu Ala Ser Leu Lys	
100 105 110	
Gln Lys Ile Trp Lys Ile Pro Ser Gly Glu Leu Leu Asn Leu Pro Tyr	
115 120 125	
Leu Glu Lys Ile Ala Lys Leu Pro Ile Pro Asp Lys Lys Ile Ile Ile	
130 135 140	

Ser Thr Gly Met Ala Thr Ile Asp Glu Ile Lys Gln Ser Val Ser Ile
145 150 155 160
Phe Ile Asn Asn Lys Val Pro Val Gly Asn Ile Thr Ile Leu His Cys
165 170 175
Asn Thr Glu Tyr Pro Thr Pro Phe Glu Asp Val Asn Leu Asn Ala Ile
180 185 190
Asn Asp Leu Lys Lys His Phe Pro Lys Asn Asn Ile Gly Phe Ser Asp
195 200 205
His Ser Ser Gly Phe Tyr Ala Ala Ala Val Pro Tyr Gly Ile
210 215 220
Thr Phe Ile Glu Lys His Phe Thr Leu Asp Lys Ser Met Ser Gly Pro
225 230 235 240
Asp His Leu Ala Ser Ile Glu Pro Asp Glu Leu Lys His Leu Cys Ile
245 250 255
Gly Val Arg Cys Val Glu Lys Ser Leu Gly Ser Asn Ser Lys Val Val
260 265 270
Thr Ala Ser Glu Arg Lys Asn Lys Ile Val Ala Arg Lys Ser Ile Ile
275 280 285
Ala Lys Thr Glu Ile Lys Lys Gly Glu Val Phe Ser Glu Lys Asn Ile
290 295 300
Thr Thr Lys Arg Pro Gly Asn Gly Ile Ser Pro Met Glu Trp Tyr Asn
305 310 315 320
Leu Leu Gly Lys Ile Ala Glu Gln Asp Phe Ile Pro Asp Glu Leu Ile
325 330 335
Ile His Ser Glu Phe Lys Asn Gln Gly Glu
340 345